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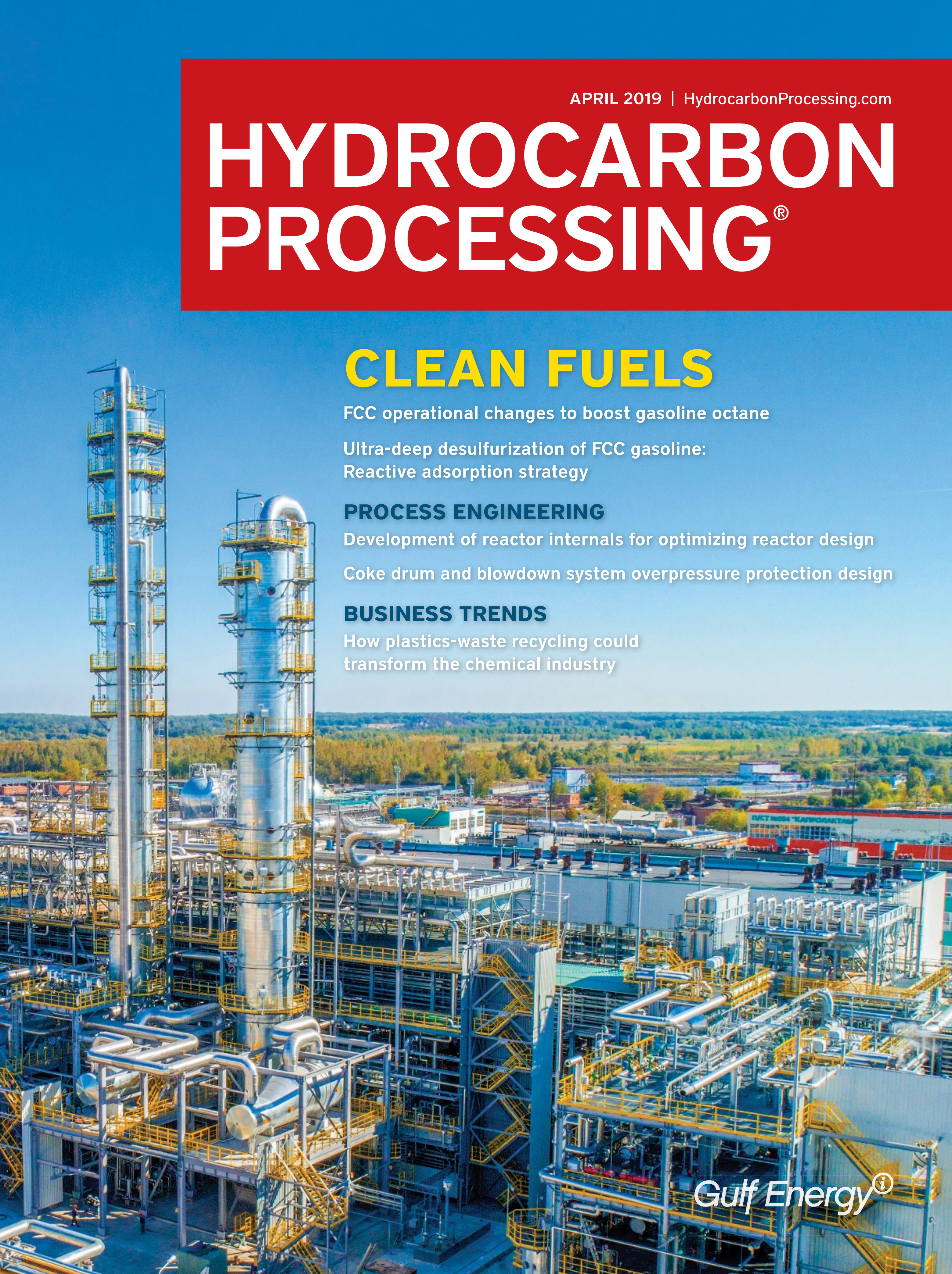

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A cost-effective approach to monitoring dangerous hydrogen sulfide gas

Hydrogen sulfide gas (H_2S) is one of the most common hazards in the oil and gas industry. H_2S is colorless, flammable and extremely toxic. The gas can accumulate in any area where oil or natural gas is processed, stored or transported, and exposure can have severe implications. The safety ranges for H_2S, in parts per million (ppm), are:

- **5 ppm–10 ppm:** Relatively minor metabolic changes
- **100 ppm:** Immediately dangerous to life and health
- **100 ppm–1,000 ppm:** Serious respiratory, central nervous and cardiovascular system effect
- **1,000 ppm–2,000 ppm:** Loss of consciousness and possible death.

In 2016, the *Denver Post* reported a story in which several oil and gas industry workers, who had originally appeared to die of natural causes, were in fact suspected of having inhaled toxic amounts of hydrocarbon chemicals in and around storage tanks. "Just breathing in these chemicals at the right amount can kill," said Robert Harrison, an occupational medicine physician at the University of California, San Francisco. Harrison said medical examiners can sometimes miss signs of toxic inhalation during a routine autopsy, which is why some of the victims were thought to have died from natural causes.[1] In addition to being life-threatening, H_2S is flammable and highly corrosive. It is an explosion hazard and impacts piping, infrastructure and facilities over time.

In oil and gas refineries and petrochemical plants, H_2S can be a major hazard, particularly in the areas of storage and transportation. Leaks in remote storage applications can result in large quantities of H_2S being released, which becomes extremely hazardous to personnel. Continuous monitoring of storage tanks for leaks and fugitive emissions is imperative for the safety of personnel and equipment, and is mandatory in most countries. Tank farms require the monitoring of H_2S near pipes and valves and around low points where the gas may settle, such as in sumps and pump pits.

Complexity, cost of H_2S monitoring.

H_2S can be detected by fixed-point gas detectors using electrochemical sensors. This technology is well understood and reliable in the protection of people and property. However, many of the sites where H_2S accumulation occurs and which pose the most danger are remote and/or difficult to reach, where the costs of installing wiring and conduit for power and communication can quickly add up to tens of thousands of dollars per measurement point. The more remote or complex the site, the more expensive the installation, which will limit the number of critical gas detectors placed in appropriate locations.

Wiring costs for wired gas detectors can be greater than other measurement devices because the sensors are commonly separated from the transmitters to facilitate monitoring for gases that are either heavier or lighter than air. This adds to the total costs of wiring, conduit and junction boxes.

Running power and communications wire and conduit, digging wire trenches, installing cable trays and physically wiring each sensor and transmitter are labor-intensive tasks. Since gas monitors are typically installed in hazardous locations, the extra labor required for detector installation, commissioning and maintenance can be a serious safety concern. Often, the challenging locations exacerbate these problems and add significantly to lost uptime and personnel costs. Even if costly wired installation is accomplished, the time required to service and calibrate traditional sensors can add significant personnel time in hazardous areas. In addition, once fixed gas detectors are installed, it is difficult and costly to move them if the conditions warrant a change.

As a result, remote and complex locations may be left unmonitored for toxic H_2S. Personnel visiting these sites are protected only by portable or personal toxic gas sensors. Thus, service personnel may enter potentially toxic situations without advanced warning, which is not a recommended best practice. In addition,

FIG. 1. Wireless gas monitors[a] provide early warning to better protect personnel and minimize downtime.

"running blind" can lead to costly, wasted maintenance trips where personnel must abandon work once gas is detected via personal monitors.

Service personnel may enter potentially toxic situations without advanced warning, which is not a recommended best practice. In addition, "running blind" can lead to costly, wasted maintenance trips where personnel must abandon work once gas is detected via personal monitors.

Benefits of wireless. Clearly, H_2S monitoring in remote and/or challenging locations is an application that is ideal for wireless technology. Wireless technology addresses many of the challenges presented by conventional wired monitors.

Wireless gas monitors make use of conventional electrochemical cell sensors. This technology is used in a majority of the wired toxic gas sensors in the market today. It is reliable and accurate. In addition, installation and commissioning costs are substantially lower than wired monitors. The overall lifecycle costs for wireless monitors are also decreased because of efficient sensor calibration and easy, lower-cost replacement.

In addition, one of the key benefits of wireless communication is that basic configuration can be accomplished remotely through the network gateway via asset management software. Local configuration can still be accomplished using handheld field communicators. Either arrangement allows for configuration in the field without the need to move the device to a non-hazardous area.

A real-world example. As an illustration of the potential benefits of wireless monitoring, let us consider a real-world example using the assumptions in **TABLE 1** and adding 10 toxic gas points to a remote oil tank battery of eight tanks without wireless infrastructure.

The problem is that sour gas may accumulate in the head-space of tanks at a remote storage facility. This is a safety concern during sampling and gauging operations. In addition, tank sidewall penetration leaks and open hatches could go unnoticed. The solution is to install H_2S monitors, one on each tank hatch, as well as two H_2S monitors on each of two low point sumps. **TABLES 1** and **2** demonstrate the cost savings achieved in installation and commissioning alone by utilizing a wireless solution, and additional savings will be realized over the life of the monitor because of efficient sensor calibration and replacement.

TABLE 1. Assumptions for cost comparison of wired vs. wireless toxic gas monitoring solution

Costs, $US	Wireless gas monitor	Wired gas detector
Detector cost	~$3,500 w/battery	~$1,750
Wiring/conduit cost per detector	N/A	~$10,000
Labor hr/device	< 1 hr	~10 hr
Labor cost, $US	$100/personnel hr	

TABLE 2. These values only account for installation and commissioning savings. Additional cost savings will be realized over the life of a wireless gas detection point via efficient sensor calibration and replacement capabilities.

Costs, $US	Wireless gas monitor	Conventional wired gas detector
Detector cost	$35,000	$17,500
Wiring/conduit	–	$100,000
Gateway	$10,000	–
Installation labor	$1,000	$10,000
Total cost	$46,000	$127,500

Selecting H_2S monitoring for an application. Monitoring H_2S at challenging locations using a wireless toxic gas monitoring system provides users with the fundamental advantages of wireless technology, including the production of reliable, continuous data that improves safety, efficiency and the environment. It greatly reduces costs and increases the speed to install and commission conventional detection devices. It allows users to place sensors where they want and need them, and to implement new applications in remote locations with total flexibility.

Other considerations should be taken into effect when selecting a wireless toxic gas monitor. A wireless gas monitor (**FIG. 1**) benefits from all the features inherent to the *Wireless*HART standard, including system reliability, security and effective power management. *Wireless*HART also enables the user to benefit from the flexibility of mesh networks and configurable update rates.

To back up the strength of *Wireless*HART communication, users should look for a device with a clear, configurable LCD display, with a screen that has multiple display modes from which to choose, including disabled, on-demand, periodic and high availability, depending on their requirements. This allows field operators to clearly understand the toxic gas threats in the area. It is also beneficial to select a monitor that offers means to directly trigger external equipment, such as beacons, alarms or annunciators in the event of an alert. This feature has the potential to protect workers from entering areas where dangerous levels of toxic gas could pose an immediate threat to their safety.

A wireless gas monitor can be used for general guidance by sending updates on gas concentration once every hour, with the LCD screen disabled to extend power module life. A user may choose to use the device as a safety monitor—providing updates to the host system every 2 sec, keeping the LCD display on constantly and utilizing a discrete output option to trigger local alarms to protect workers.

The less time users need to spend interacting with field devices, the better; therefore, ease of maintenance should be considered when selecting a gas monitor. Minimizing interaction time not only decreases costs for users, but it also improves safety since fewer personnel hours need to be spent in hazardous areas. In addition, some devices utilize lithium power modules that, depending on ambient conditions, network setup and user-configured update rate, are capable of a 4-yr service life, even further reducing maintenance requirements.

Wireless gas monitors should meet the performance requirements that characterize top-quality wired toxic gas detectors. Gas detectors are compared with one another based on their ability to accurately and quickly detect the presence of gas. Accurate, high-performance monitoring in a wireless gas monitor should be comparable to conventional wired gas monitors with an accuracy of ±3 ppm or 10% of the reading, whichever is greater. The update rate is the frequency at which new measurements and device statuses are transmitted over the wireless network. The update rate range is 1 sec–1 hr, and the default update rate is often 8 sec. It is often advisable that advanced wireless gas monitors take measurements every 2 sec, and users should be able to adjust the update rate during configuration. Users should select a gas monitor that uses industry-standard sensing technology and makes no sacrifices in terms of accuracy or speed of response.

Electrochemical sensors have a finite service life. This life is dependent on ambient conditions, but it typically will last from 1.5 yr–2 yr in service. It is best for users to select a sensor that is contained within a replaceable, intrinsically safe module that can be removed and installed without tools, so there is no need to remove the device from the hazardous area. Some wireless gas monitors also have diagnostic capability that can communicate that the sensor is nearing the end of its useful life, helping users plan replacement operations efficiently.

Due to the hazardous nature of the applications, wireless gas monitors should carry the North American, European and global certifications necessary for installation in hazardous areas. Many users may also require a wireless gas monitoring solution that can handle harsh conditions. As such, these devices should have an International Protection Marking ingress protection rating of IP66 and a temperature range of –40°C to more than 50°C (–40°F to more than 122°F).

Wireless toxic gas monitors make it possible for users to extend the protection of toxic gas monitoring to their most challenging applications, protecting their personnel and property and saving time and money in maintenance. HP

NOTES

[a] Refers to Emerson's Rosemount 928 wireless gas monitor

LITERATURE CITED

[1] Whaley, M., "Toxic vapors suspected in deaths of three Colorado oil and gas workers," *Denver Post*, April 23, 2016.

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